DESIGN REPORT FOR GAS CONTROL FACILITIES

Proposed Southbay Drive-In Theatre
in the City of Carson, California

Background Information

The 24-acre project site is located in the city of Carson, California southeasterly of the junction of the San Diego (I-405) and Harbor Freeways (Figure 1). The site was formerly used for disposal of refuse by Southwest Conservation, Incorporated under Los Angeles County Industrial Waste Disposal Permit Number 3366 and Los Angeles Regional Water Quality Control Board Resolution Number 64-116. Disposal operations commenced in 1964 and were continued until March, 1971. Refuse disposal was accomplished in an area of approximately 22 acres of the site. (A stormwater sump in the northwest corner of the property comprises the balance of the site).

Refuse materials delivered totaled an estimated 500,000 tons of Group 2 wastes (household refuse, yard trimmings, etc.). Disposal of Group 2 waste was restricted to elevations +0.5 ft above sea level or greater, and was ultimately placed to a depth of from 30 to 32 ft above sea level to conform to the approved filling plan dated August, 1964.(1) The depth of fill averages about 30 ft.

Oily waste was disposed in an area near the northeast corner of the site from 1969 to 1971. The oily waste was to have been mixed and spread with the cover material, however, proper mixing was not performed and ponded oily waste occurred. Evidence of these ponds is still visible on the site surface in certain areas, although no liquid remains.

Heavy equipment (track dozers and motorized scrapers) were reportedly employed to spread and compact the waste material. No information is available on the degree of compaction achieved on the waste materials, however, limited density determinations by SCS indicate good levels of compaction were achieved (in excess of 1,000 lb per cu yd). Borings by others indicate that the site is underlain by relatively uniform, fine grain sediments consisting of silt, fine sand, and clay.(2) Drilling logs of wells in the vicinity of the site indicate that laterally, there is an irregular pattern of discontinuous lenses of fine sands, silts, and clays in the upper fine grained sediments.(3)

The proposed use for the site is a 6 screen drive-in theatre with a concession building. Minor grading including the relocation of refuse on-site will be necessary to fulfill overall project requirements. A minimum compacted soil cover depth of 2 ft is to remain over the entire site following grading, and will be topped with asphalt to accommodate theatre traffic.(4)

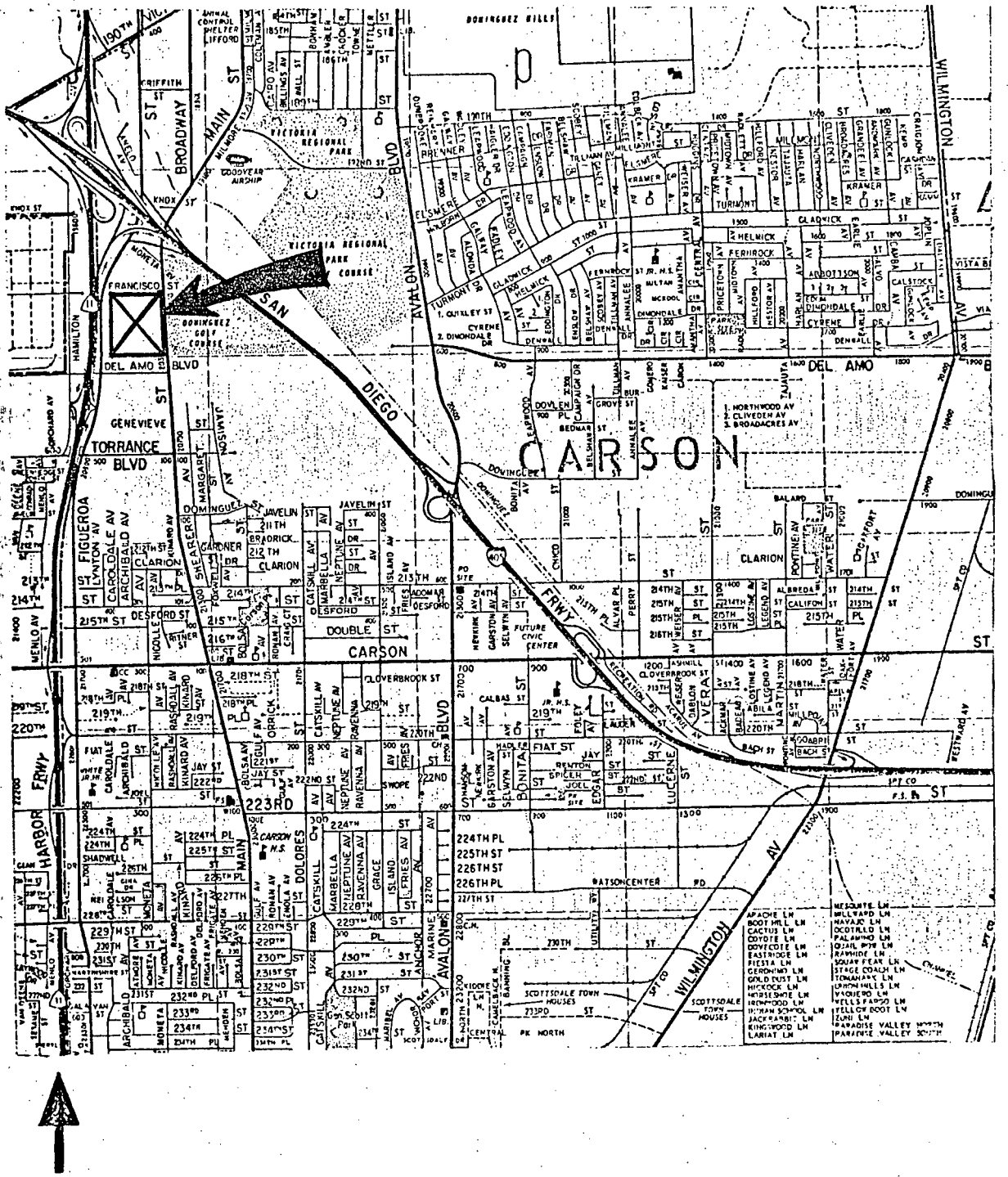

Figure 1. Site Location Map

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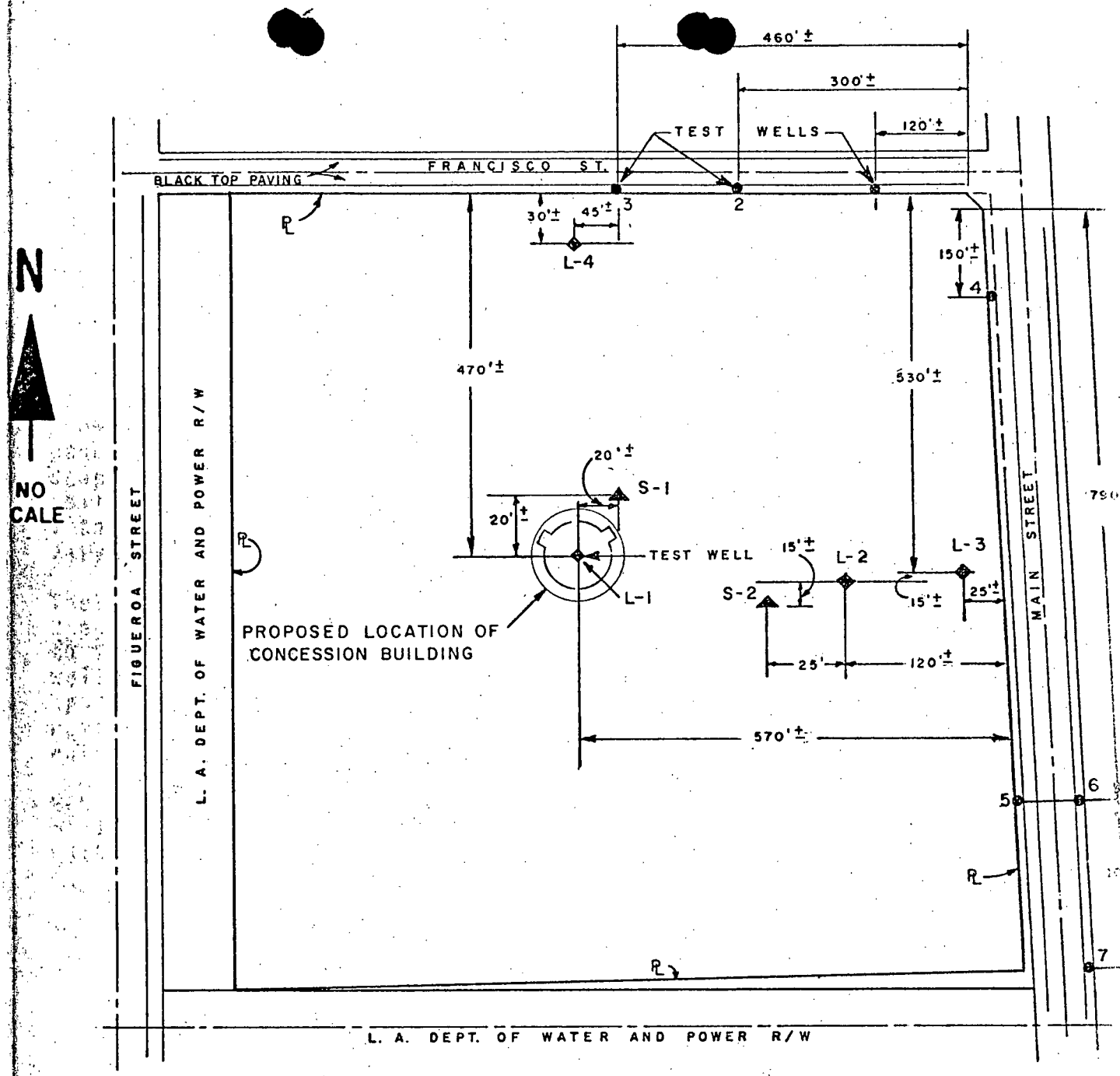

Figure 2. Approximate Locations of SCS Test Wells

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depth, gas concentration and composition, and to estimate in-place refuse densities. One well was placed at the proposed location of the concession building, the other three near the northerly and easterly boundaries of the property. The depth of these wells ranged from 17 to 32 ft and are designated as L-1 through L-4 on Figure 2. The remaining two wells (S-1 and S-2) were placed in the soil cover material to determine the presence of methane gas in the cover material. Gas sampling probes were placed at various depths in each of the test wells.

Deep test wells placed into the refuse fill were installed using a drilling rig with 18 in. diameter core barrel and/or a 24 in. diameter bucket. Shallow test wells (5 ft or less) were drilled manually using a post hole auger. Boring logs for each of the deep test wells are included as Appendix B of this report. Final soil cover at the deep test well locations was found to range from 1 to 8 ft in depth, and to be composed primarily of silty-sand with varying amounts of gravel.

Test wells (designated as 1-7) and probes approximately 3-1/2 ft deep were placed along the north and east perimeters of the site to identify methane gas migration beyond the site boundaries. The wells were drilled outside the property lines of the site corresponding to locations of structures located immediately north and northeast of the site. All such wells and probes were placed in natural soil.

Gas samples were obtained from probes in each test well location at least once. Samples were taken using one of the following methods:

- Extraction of gas into a 250 ml. gas sample bottle for analysis of CH_4 and CO_2 concentrations by gas chromatography.
- Use of an MSA explosimeter to sample for the presence of CH_4 gas concentrations of from 0% to 100% of the lower explosive limit, L.E.L., (5% methane concentration by volume in air).*
- Use of an MSA H_2S detector to sample for the presence of H_2S concentrations of from 0 to 50 parts per million (ppm) in the refuse fill.

In addition to test well sampling, the meter boxes along Francisco Street previously monitored by PJB were also tested using the MSA explosimeter on four occasions to assess the effectiveness of the existing gas ventilation system. Tables 1 through 3 present the results of all gas sampling and analysis.

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*Methane concentrations of from 5 to 15% in air are explosive while concentrations greater than 15% in the air are combustible.

TABLE 1

RESULTS OF GAS PROBE TESTING

Test Well	Date Installed	Probe Depth	Test Method/Date of Sample: MSA Explosimeter(1) 3/7/75 CH_4	MSA Explosimeter(1) 3/26/75 CH_4	Gas Chromatograph(2) 3/7/75 CH4	3/7/75 CO_2	3/7/75 Air	3/26/75 CH_4	3/26/75 CO_2	3/26/75 Air	5/5/75 CH_4	5/5/75 CO_2	5/5/75 Air
On-Site:													
L-1	2/19/75	10'	--*	--	54.5	40.5	5.0	39.9	34.4	25.7	57.3	42.7	0
	2/19/75	20'	--	--	57.2	41.3	1.5	55.1	46.4	Trace	53.4	43.6	3.0
	2/19/75	30'	--	--	53.5	39.7	6.8	54.3	36.9	8.8	48.8	36.6	14.6
L-2	2/20/75	10'	--	--	58.8	39.5	1.7	45.7	31.5	22.8	51.2	36.1	12.7
	2/20/75	20'	--	--	63.0	32.3	4.7	59.7	32.7	7.7	57.8	31.6	10.6
	2/20/75	30'	--	--	67.2	34.1	0	65.3	34.3	0.5	63.4	36.6	0
L-3	2/21/75	12'	100%+	--	--	--	--	57.1	31.5	11.3	65.2	34.8	0
L-4	3/3/75	8'	--	--	--	--	--	54.2	35.4	69.0	20.5	18.9	60.6
	3/3/75	15'	--	--	--	--	--	**	**	**	61.0	43.0	0
	3/3/75	22'	--	--	--	--	--	17.0	14.0	69.0	--	--	--
S-1	2/21/75	2"	100%+	100%+	--	--	--	11.5	9.7	78.8	22.8	23.0	54.2
	2/21/75	1'	100%+	100%+	--	--	--	23.0	23.7	52.3	45.4	38.3	16.3
	2/21/75	2'	100%+	100%+	--	--	--	14.2	17.5	68.4	34.6	35.3	30.1
S-2	3/7/75	2"	--	0	--	--	--	0	0	100	0	0.5	99.5
	3/7/75	1½'	--	0	--	--	--	0	0	100	0	1.4	98.6
	3/7/75	3½'	--	0	--	--	--	0	0	100	0	3.2	96.8

* No sample taken
** Water in Hole

(1) Reading is percent of L.E.L. for methane.
(2) Reading is percent by volume.

TABLE 1 - continued

Test Well	Date Installed	Probe Depth	Test Method/Date of Sample: MSA Explosimeter(1) 3/7/75 CH_4	MSA Explosimeter(1) 3/26/75 CH_4	Gas Chromatograph(2) 3/7/75 CH_4	3/7/75 CO_2	3/7/75 Air	3/26/75 CH_4	3/26/75 CO_2	3/26/75 Air	5/5/75 CH_4	5/5/75 CO_2	5/5/75 Air
Off-Site:													
1	2/19/75	3½'	100%+	--	--	--	--	--	--	--	--	--	--
2	2/19/75	3½'	100%+	100%+	--	--	--	51.8	36.6	11.6	--	--	--
3	2/19/75	3½'	100%+	100%+	--	--	--	47.5	31.5	20.7	--	--	--
4	2/19/75	3½'	0	--	--	--	--	--	--	--	--	--	--
5	2/19/75	3½'	0	--	--	--	--	--	--	--	--	--	--
6	2/19/75	3½'	100%+	--	--	--	--	--	--	--	--	--	--
7	2/19/75	3½'	100%+	--	--	--	--	--	--	--	--	--	--

* No sample taken.
** Water in hole.

(1) Reading is percent of L.E.L. for methane.
(2) Reading is percent by volume.

TABLE 2

RESULTS OF HYDROGEN SULPHIDE (H_2S) TESTING(1)

Test Well	Probe Depth	Results(2)
L-1	10'	Probe pulled out
	20'	" " "
	30'	" " "
L-2	10'	50 ppm
	20'	25 ppm
	30'	50+ ppm
L-3	12'	30 ppm
L-4	8'	28 ppm
	15'	50+ ppm
	22'	Water in probe
S-1	2"	No sample taken
	1'	" " "
	2'	35 ppm
S-2	2"	No sample taken
	1½'	" " "
	3½'	0 ppm

(1) Testing conducted on May 5, 1975.

(2) Determined using MSA Hydrogen Sulfide Detector Model No. 74665.

TABLE 3

RESULTS OF GAS MONITORING OF METER BOXES
ON THE NORTH SIDE OF FRANCISCO STREET

Test Location(2)	Test Results/Date(1)			
	3/7/75	3/26/75(3)	6/10/75(3)	6/13/75
East of 229	-	-	40	10
229 W. Francisco St.	0	0	100+	100+
303 W. Francisco St.	0	0	100+	100+
305/9 W. Francisco	0	box flooded	0	0
321 W. Francisco St.	box flooded	0	5	0
331 W. Francisco St.	0	0	100+	0
Western Refuse	0	100+	100+	100+

(1)Percent of L.E.L. for methane as determined with MSA explosimeter.
(2)Water meter boxes.
(3)Gas ventilation fan system was not functioning (electricity at the site was disconnected on March 11, 1975 and was restored on June 12, 1975).

The sampling results show an abundance of methane gas (up to 65% by volume) and significant concentrations of H_2S (in some instances in excess of 50 ppm) in the refuse. These concentrations indicate that anaerobic decomposition of the refuse is well established.

No methane gas concentrations were detected in the two wells closest to the property line along Main Street, (Wells 4 and 5), however, readings in excess of 100% L.E.L. were detected in those wells on the east side of Main Street (Wells 6 and 7). The origin of these gas concentrations, however, is not certain since the property along the east side of Main Street adjacent to the wells has also been utilized for refuse disposal. As previously mentioned, results from gas monitoring of meter boxes along the north side of Francisco Street by PJB (Appendix A) also revealed methane concentrations of from 0 to 100% L.E.L.

It can be concluded from the test results that subsurface gas is migrating to the north from the subject site, and that the existing gas ventilation system is only partially effective in preventing gas migration. Although no conclusive evidence was found to indicate gas migration to the east, however, project site improvements, particularly the paving of the site, could cause migration to occur in that direction as well.

Refuse samples were taken from test wells L-1, L-2 and L-3 (see Figure 2) during drilling operations to determine the approximate composition, moisture content and in-place densities of the refuse at various locations on the site.

Moisture content in the refuse ranged from 32% to 46% by wet weight; refuse moisture contents in excess of 40% are generally an indication that surface waters (rainfall and/or runoff) may be reaching the refuse. It appears that this may be occurring at the site since free water was found in test wells L-2, L-3, and L-4.

The organic composition of the sampled refuse ranged from approximately 20 to 40% by weight, which is considerably less than would be expected for a Group 2 refuse fill. However, the high percentages of inerts may reflect the relatively rapid decomposition contributed to by available moisture. Table 4 presents the results of refuse moisture content and organic composition at each of the above test well locations.

Mitigation Measures

Based on available background data, and on the results of SCS field investigations, it is apparent that various measures must be implemented, in conjunction with the construction of the proposed drive-in theatre, to mitigate potential problems arising from the former use of the site for waste disposal. Problems which need resolving include:

TABLE 4

REFUSE CHARACTERISTICS

Test Well	Depth (ft.)	Refuse Characteristics: Organics (% by weight)	Moisture (% by weight)	Inerts (% by weight)
L-1	14	36.4	31.99	31.61
	24	40.71	43.29	16.00
	30	27.16	40.87	31.97
L-2	12	23.66	46.17	30.17
	22	19.80	32.20	48.00
L-3	5	22.28	33.33	44.39
	17	24.20	32.35	43.45

- The areal extent of exposed refuse should be covered as soon as practical with a minimum of 6 inches of soil. All exposed refuse shall be so covered at the end of each working day.

Prevention of Off-Site Gas Migration

Three systems were considered to prevent gas migration to adjacent properties. These were:

1) Removing the methane gas generated within the fill so that no gas is available to migrate from the site. Once collected, this gas could either be utilized on-site, or disposed by flaring. As reported in our communication dated June 3, 1975, sufficient quantities of methane gas are available for generation of on-site electrical usage requirements for an estimated 4 to 8 years. It was also determined, however, that at current electrical rates, an estimated net cost of about $3,000 per year would be incurred if a recovery system were used as an alternative to main line power.

2) Construction of a natural draft ventilation system consisting of a series of gravel filled wells located along the property boundaries adjacent to Main and Francisco Streets. A natural draft system would reduce the methane migration rate by eliminating convective flow, but will have little or no effect on migration by diffusion. This type of system was thus deemed unsatisfactory due to the high methane concentrations encountered within the landfill.

3) Construction of a forced gas ventilation system consisting of a series of gravel filled wells located within the property boundaries adjacent to Main and Francisco Streets. A forced ventilation system will cause the gas to flow via convection to the gravel filled wells and thereby preclude migration of gas from the site. This type of system was deemed to be the most desirable in terms of both effectiveness and cost.

Details for the selected system are presented on "Construction Plans for Gas Control Facilities - South Bay Six Drive-In Theatre," Sheets 1-4, dated June 25, 1975. In general, the system is composed of the following:

(1) A series of nine 24 in. diameter gravel filled wells drilled vertically to a depth of about 30 ft. A 4 in. diameter pvc pipe approximately 25 ft long is to be placed in each well to aid gas collection. The lower 10 ft length of the pipe will be perforated. The wells

are to be spaced at 240 ft intervals adjacent to the property line along Francisco and Main Streets. A maximum withdrawal rate of 27.5 cfm from each well has been calculated as necessary to prevent off-site gas migration.

(2) A 4 - 6 in. diameter horizontal pvc plastic header pipe to collect gas from each well. Because of probable differential settlement within the fill, flexible couplings are specified for connecting each well head to the header pipe.

(3) The blower currently a part of the forced gas withdrawal system along Francisco Street will be salvaged for use in the recommended system. Flame arresters and control valves are to be placed both upstream and downstream from the blower for safety and for flow regulation.

(4) Miscellaneous measuring devices including pressure gauges, a thermometer to monitor gas temperatures, and a low loss flow tube to monitor gas withdrawal rates.

Concentrations of H_2S gas of up to 50+ ppm were found within the landfill, and a sample taken from the vent stack of the existing PJB blower system indicated H_2S concentrations of from 1-3 ppm. The existing vent stack extends approximately 20 ft above the surrounding ground surface and sufficient dispersion of the H_2S occurs since no odors were detectable either near or downwind from the stack. Although a larger withdrawal system is proposed, it is anticipated that the stack concentrations of H_2S will be no greater than of the existing system. This assumption reflects the fact that the perforated portions of the withdrawal wells are located in existing soil. This soil will act as a biological filter thereby removing a large percentage of the H_2S gas.

However, if the H_2S gas creates a nuisance odor, the proposed system can be readily expanded to incorporate gas cleaning. This phased approach is as follows:

- Phase I would be to install the proposed system without gas cleaning for H_2S removal, however, space has been provided for gas cleaning in the event it becomes necessary.

- A permit from the Air Pollution Control District (APCD) is not required for this system. If a odor problem is created, however, Phase II must be implemented.

- Phase II would consist of the addition of an activated carbon or zeolite chemical adsorption filter media to remove H_2S gas from the gas stream, or a combustion

placed over the proposed concession building location for a period of not less than 30 days to reduce the amount of future settlement beneath the concession building. Routine inspection of the floor slab for signs of distress, and of the ground area around the periphery of the slab will be performed. Maintenance will be required should any significant cracks occur or if ground settlements expose any portion of the underslab area.

The proposed grading plan (4) provides for slopes to conduct rainfall runoff to appropriate drainage facilities. Regularly scheduled maintenance must be provided to maintain adequate slopes for drainage and to prevent ponding of water on-site. Settlement of refuse will continue for several years and may not be uniform - thus the necessity for regular maintenance of slopes.

Monitoring Program for Gas Control Facilities

To assure that all elements of the gas control system are and will continue to work effectively, a routine post-construction monitoring program must be implemented. Monitoring at the site shall be implemented by SCS Engineers according to the following schedule and continue until all evidence of methane gas generation from the fill has ceased:

- Once per week for the first month following completion of all site improvements;
- Monthly for the remainder of the first full year;
- Once every third month thereafter.

The monitoring program shall include the following inspections:

- The forced gas withdrawal system to ensure that each element is functioning properly. (Initial monitoring periods will be used to help optimize gas withdrawal rates from the landfill based on actual field conditions.) The flow rate will be recorded and a sample obtained from the vent stack for analysis of methane and hydrogen sulfide concentration. A subjective check for odors in the area beneath and at various distances downstream from the exhaust stack will be made.
- The meter boxes on the north side of Francisco Street will be tested for the presence of methane using the MSA explosimeter. At least two shallow (approximately 5 ft) monitoring wells will be maintained adjacent to the property line along Francisco and Main Streets for similar testing.

- Various locations within the interior of the concession building and the fee booths will be tested for detectable concentrations of CH_4 gas using the MSA explosimeter.

- A random sample of the surface gas venting wells will be checked for the presence of CH_4 gas using the MSA explosimeter and for odors.

- The floor slab of the concession building will be checked for any significant cracking and the outside periphery of the slab viewed for any ground settlement which has exposed the underside of the slab to the atmosphere.

- Accessible vertical vent pipes on the concession building and fee booths will be checked for the presence of methane using the MSA explosimeter.

- The paved surface of the site will be inspected for the presence of differential settlements and surface cracking. Locations of excessive settlement (sufficient to prevent effective site drainage) and surface cracking will be recorded on a site plot plan.

- Any other occurrences which the SCS inspector believes to warrent attention and which relates to the former use of the site for refuse disposal will be noted.

SCS will perform this monitoring on the required schedule of frequency and submit a written report to the theatre owner and to the city of Carson, identifying maintenance requirements and certifying the continued viability of the gas control facilities.

References

1. "Operation Plan - Cut and Cover Operation," Southwest Conservation Dump, prepared by Charles C. Miller, August, 1964.

2. "Feasibility Study of Proposed Lowering of Base of Main Street Waste Disposal Site," Moore and Taber - Engineers and Geologists, May 22, 1965.

3. "Investigation of Main Street Waste Disposal Site in the West Coast Basin," Bookman and Edmonston Consulting Civil Engineers, June, 1965.

4. "Plot Plan - Grading," prepared by Vincent G. Raney, A.I.A., dated May 23, 1975.

5. "Gas Disposal Facilities El Camino Landfill, City of Carson - Operation Manual," Pomeroy, Johnston and Bailey, January, 1973.